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# Flight Trial Architectures Supporting Migration to Broadband Internet Protocol (IP) for Airline Operations Communications (AOC) and Air Traffic Services (ATS) Communications

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**Boeing, Phantom Works, Advanced ATM**

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# Agenda

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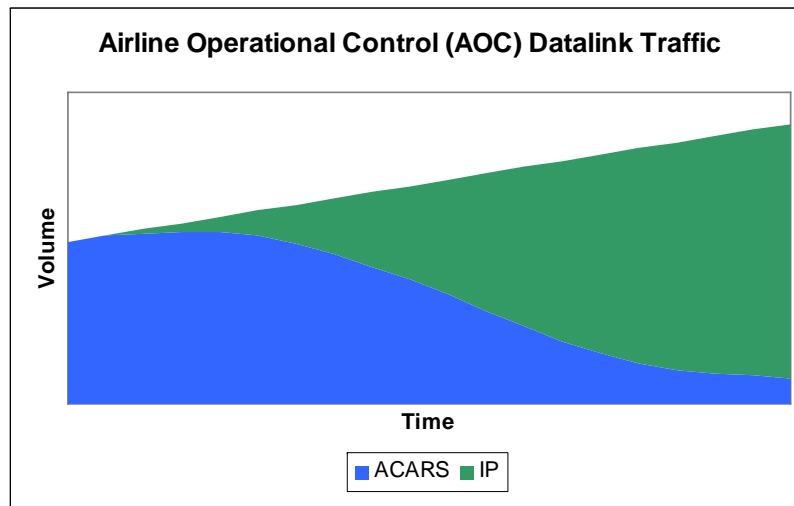
- **Background**
- **Operational Architectures**
- **Lab Demonstration/Flight Trial  
Architecture Alternatives**

# Why Broadband IP?

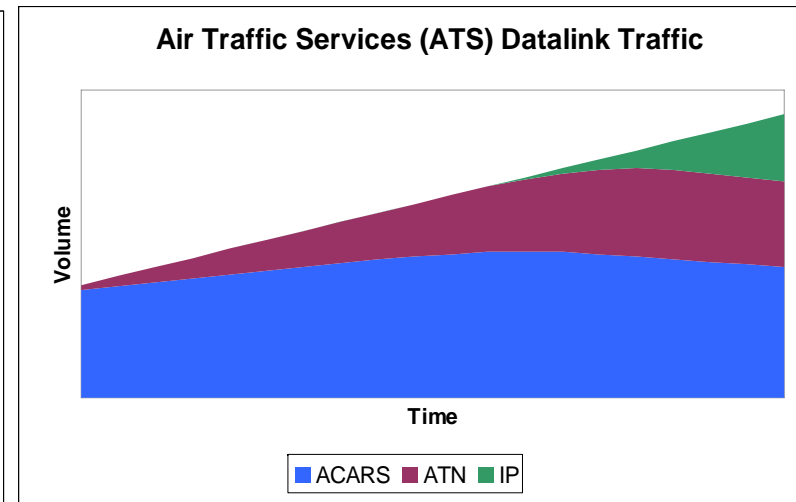
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>90 % Traffic



<10 % Traffic



- AOC is going directly to broadband IP, by-passing ATN, for lower cost per bit and higher capacity
- AOC service experience with broadband IP is critical to demonstrating adequacy for ATS
- ATS will migrate to broadband IP, but not in the near future. For interim, monitor market demand for ATN.
- ACARS and ATN will continue to exist in the foreseeable future, do not wait for broadband IP

**AOC will drive and pay for aeronautical broadband IP**

# Operational & Flight Trial Architecture

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**Need to have firm understanding of possible operational architectures to properly plan flight trials:**

- **What functionality needs to exist on the aircraft?  
Where should it reside?**
- **What functionality will need to exist on the ground?  
Where should it reside?**
- **What are the most important architecture issues that need resolution? Plan to specifically target these in the development and execution of the lab demonstrations/flight trials.**

# Broadband IP Migration, Operational Architecture

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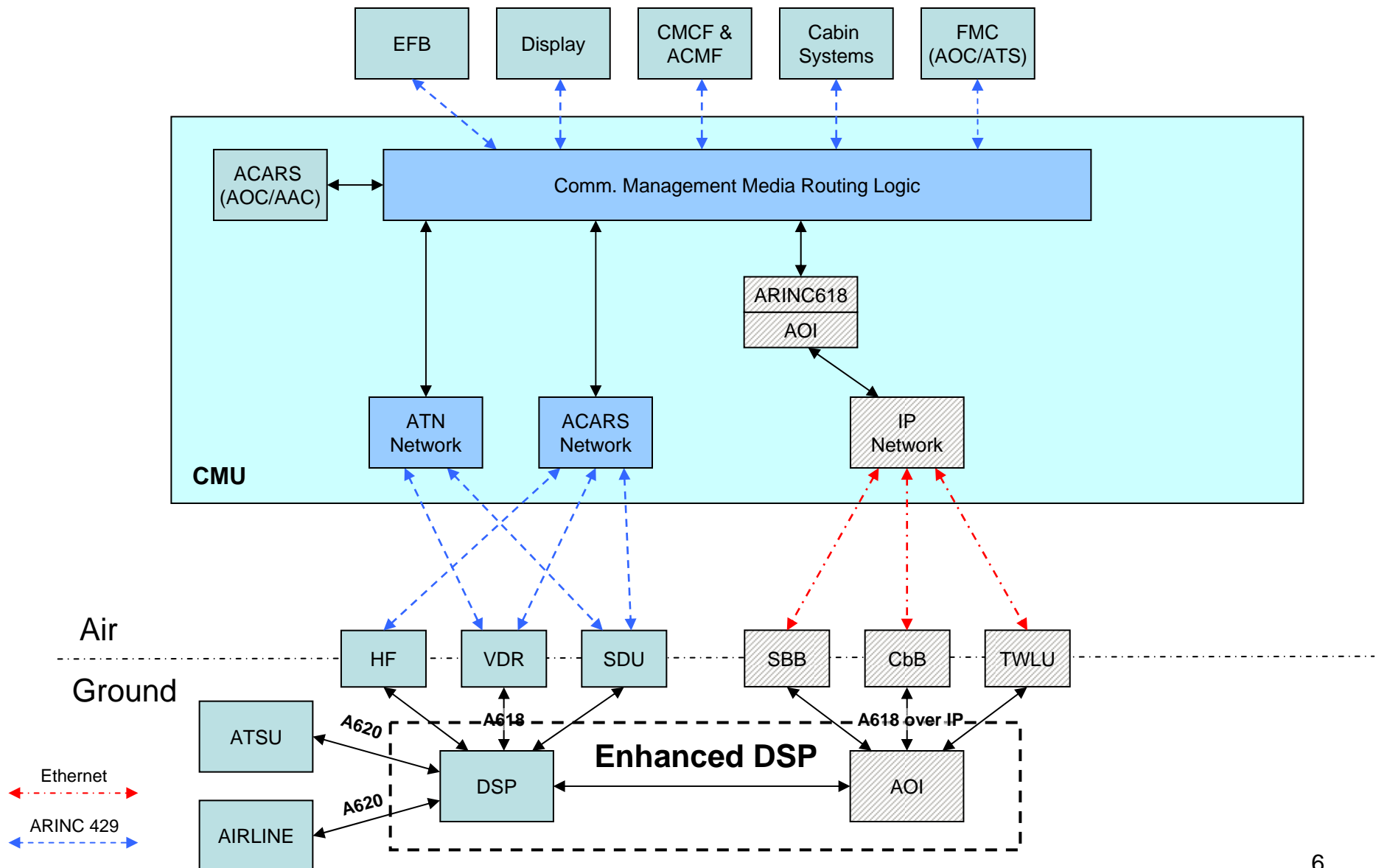
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- **Existing Environment Maintained:**
  - Existing or Planned ACARS (AOC/AAC & ATS) and ATN (ATS)
- **Initial Architecture:**
  - ACARS over IP (ARINC 618 over Broadband IP) (AOI)
  - Fastest path to incorporating broadband IP sub-networks
  - Ensures backwards compatibility
  - **Phase 1:** Add AOC/AAC ACARS over Broadband IP (AOI)
  - **Phase 2:** Add ATS ACARS (FANS) over Broadband IP (AOI)
- **Native IP Architecture:**
  - Native IP applications over broadband IP; end-to-end IP
  - In addition to the above, again ensuring backwards compatibility
  - **Phase 3:** AOC/AAC Native IP over broadband IP
  - Provides the groundwork for ATS Native IP, including SWIM Enabled Applications; When applications are defined

# Operational Logical Architecture (Phase 1 & 2)

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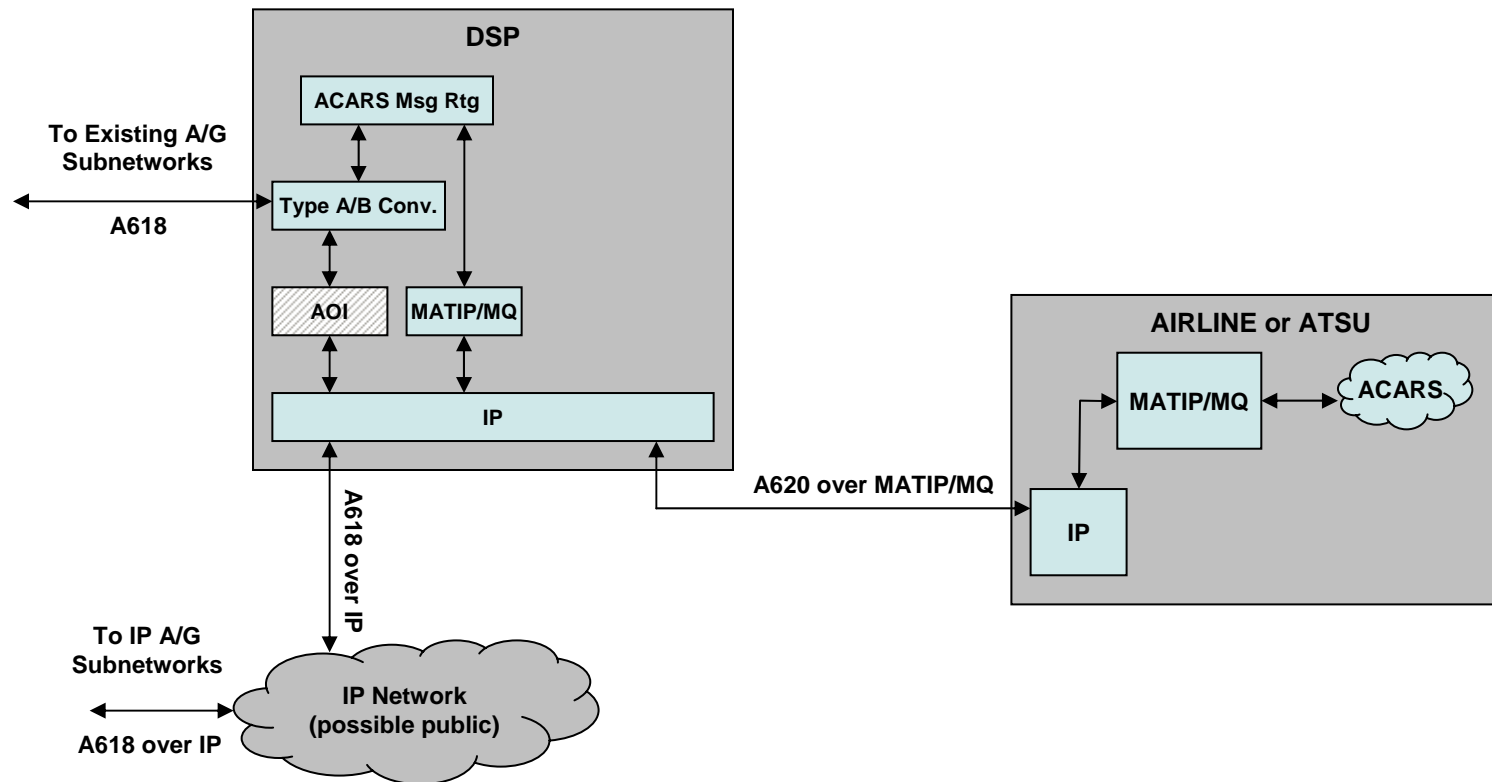
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# Operational Ground Logical Architecture (Phase 1 & 2)

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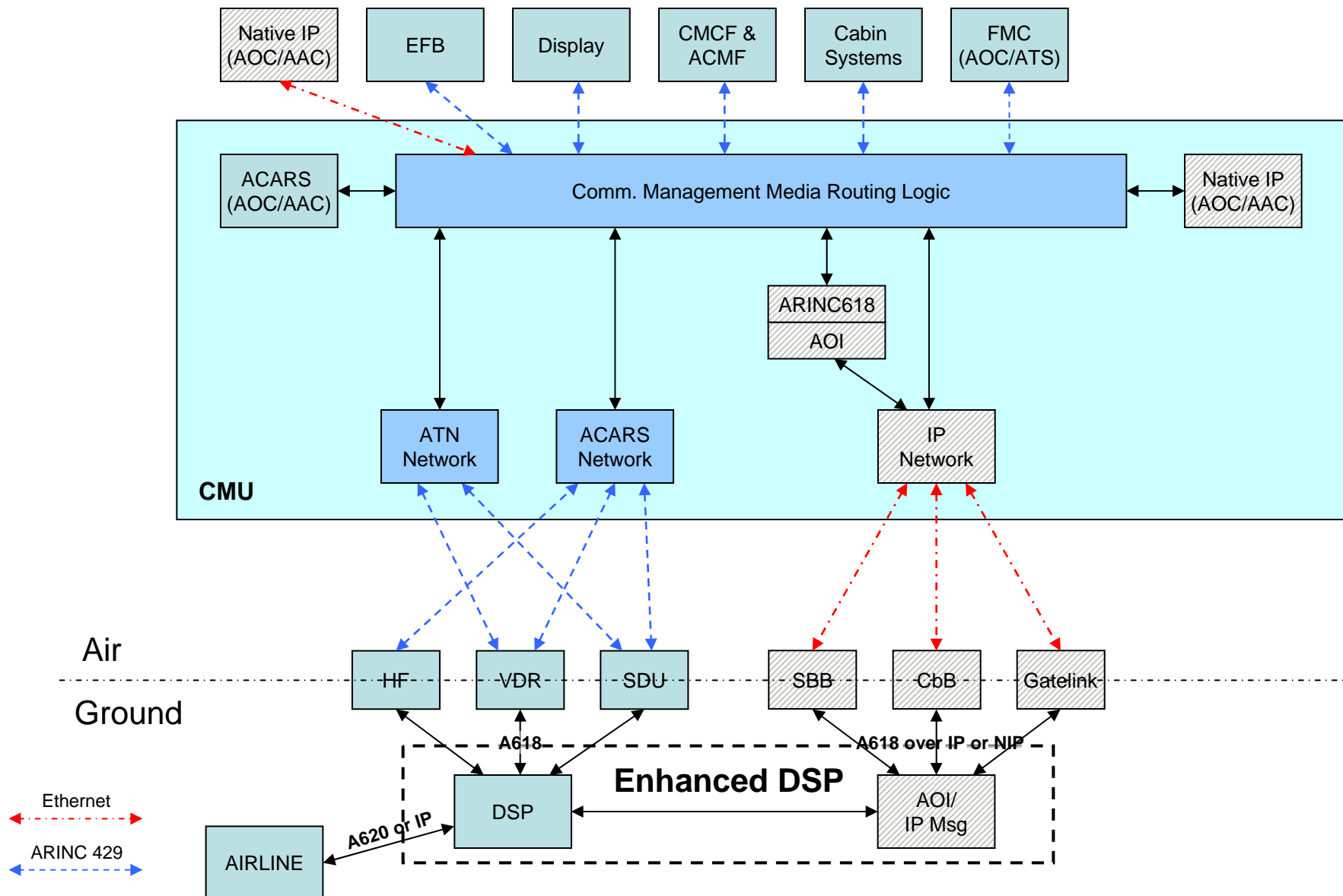
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# Operational Logical Architecture (Phase 3)

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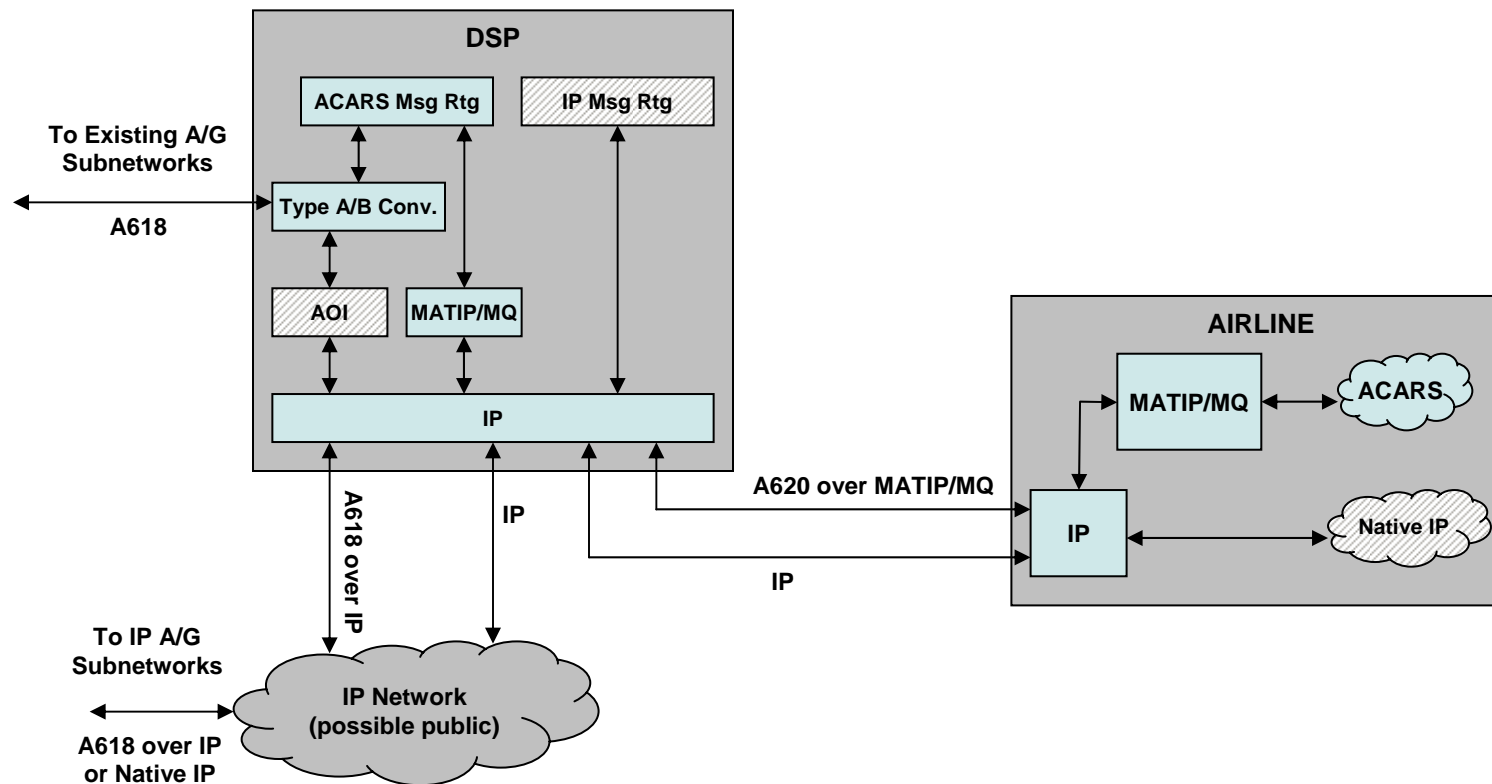




# Operational Ground Logical Architecture (Phase 3)

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# Lab Demonstration/Flight Trial Objectives

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- **A progressive series of lab demonstrations leading to flight trials, where warranted, to accelerate the certification of broadband IP for use with AOC followed by ATS**
- **Demonstrate end-end connectivity utilizing broadband IP A/G sub networks**
  - AOC/AAC over ACARS over broadband IP
  - ATS over ACARS (FANS) over broadband IP
  - Native IP AOC/AAC applications over broadband IP
- **Gather data in the following areas for validation of design and establish initial certification artifacts:**
  - Traffic Volume (Demand)
  - Transaction Time (Latency)
  - Availability
  - Continuity
  - Integrity (failure, retransmit, % delivered to the intended addressee)

# Architecture Alternatives

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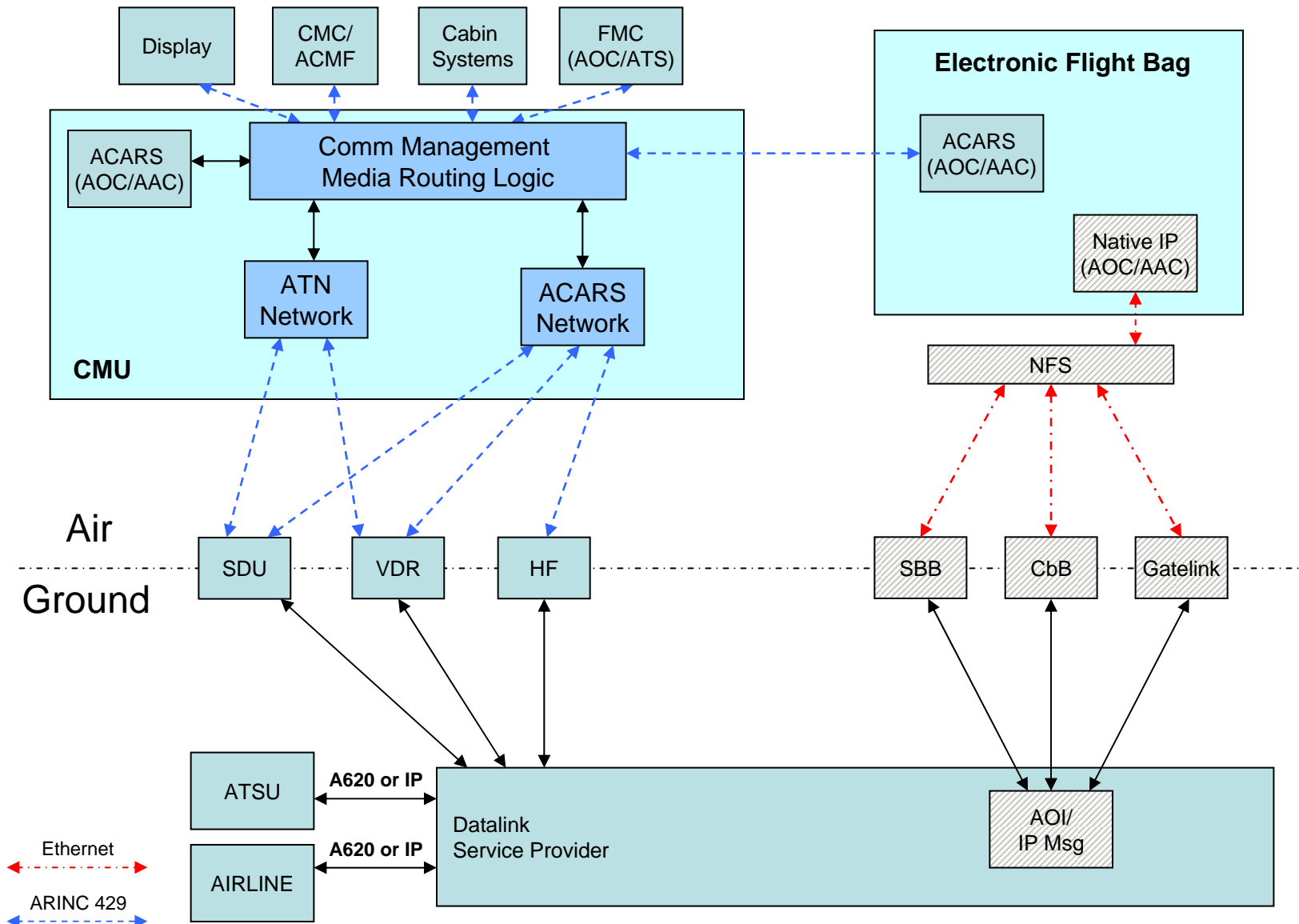
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- **Location of AOI in Aircraft**
  - CMU
  - Electronic Flight Bag (EFB)
  - Network File Server (NFS)
  - ...
- **Location of AOI on the Ground**
  - Traditional DSP
  - Third Party DSP/Gateway
  - Airline/ATSU
  - ...
- **Location of IP router in Aircraft**
  - CMU
  - CoreNet
  - Network File Server (NFS)
  - ...
- **Location of IP Message Router**
  - No Messaging (Peer to Peer)
  - Traditional DSP
  - Third Party Gateway
  - Airline/ATSU
  - ...
- **Aircraft Application Location**
  - CMU
  - FMC
  - EFB
  - ...
- **Application Type**
  - Operational
  - Test

# Alternate Architecture Configuration (No CMU Updates, Native IP Applications in EFB)

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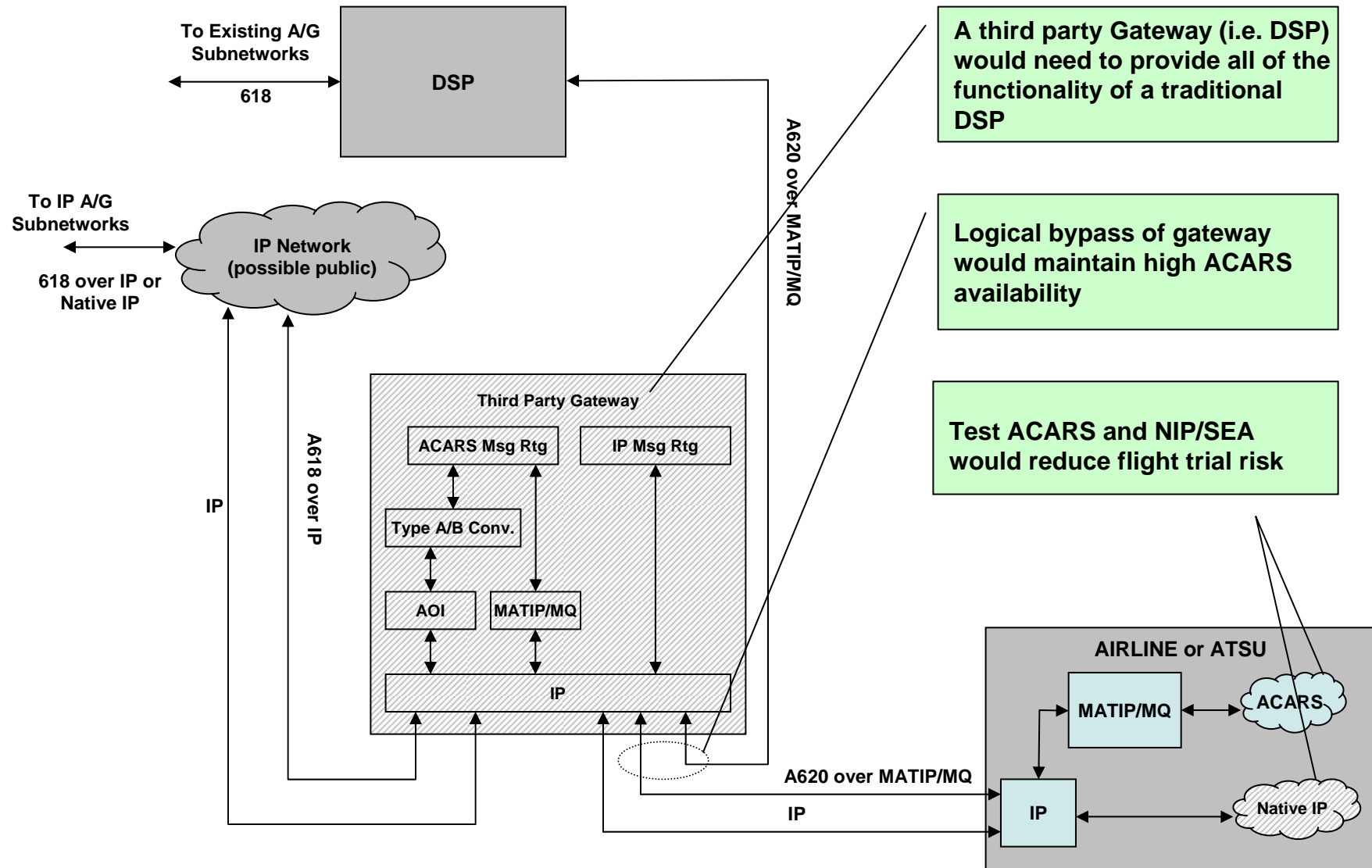
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# Alternate Ground Architecture Configuration (Third Party Gateway)

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# Next Steps

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- **Trade Studies, Lab Demonstration, and Flight Trials**
  - Engage Potential Lab Demonstration/Flight Trial Partners
  - Develop AOI Design Alternatives
  - Develop Flight Trial Lab Plan
  - Develop Flight Trial Description Document
- **Prerequisites to an IP Certification Plan**
  - Complete definition of aircraft and ground components involved in the transmission of datalink over IP
    - Maintaining backwards compatibility with ACARS and ATN
  - Complete definition of services/applications supported for phase 1
  - Create certification artifacts
    - Operational Environment Document (OED)
    - Operational Hazard Assessment (OHA)
    - Safety and Performance Requirements (SPR)
    - Allocated Safety Objective Requirements (ASOR)
    - ....
  - Repeat previous two bullets for phase 2 and phase 3

# Questions?

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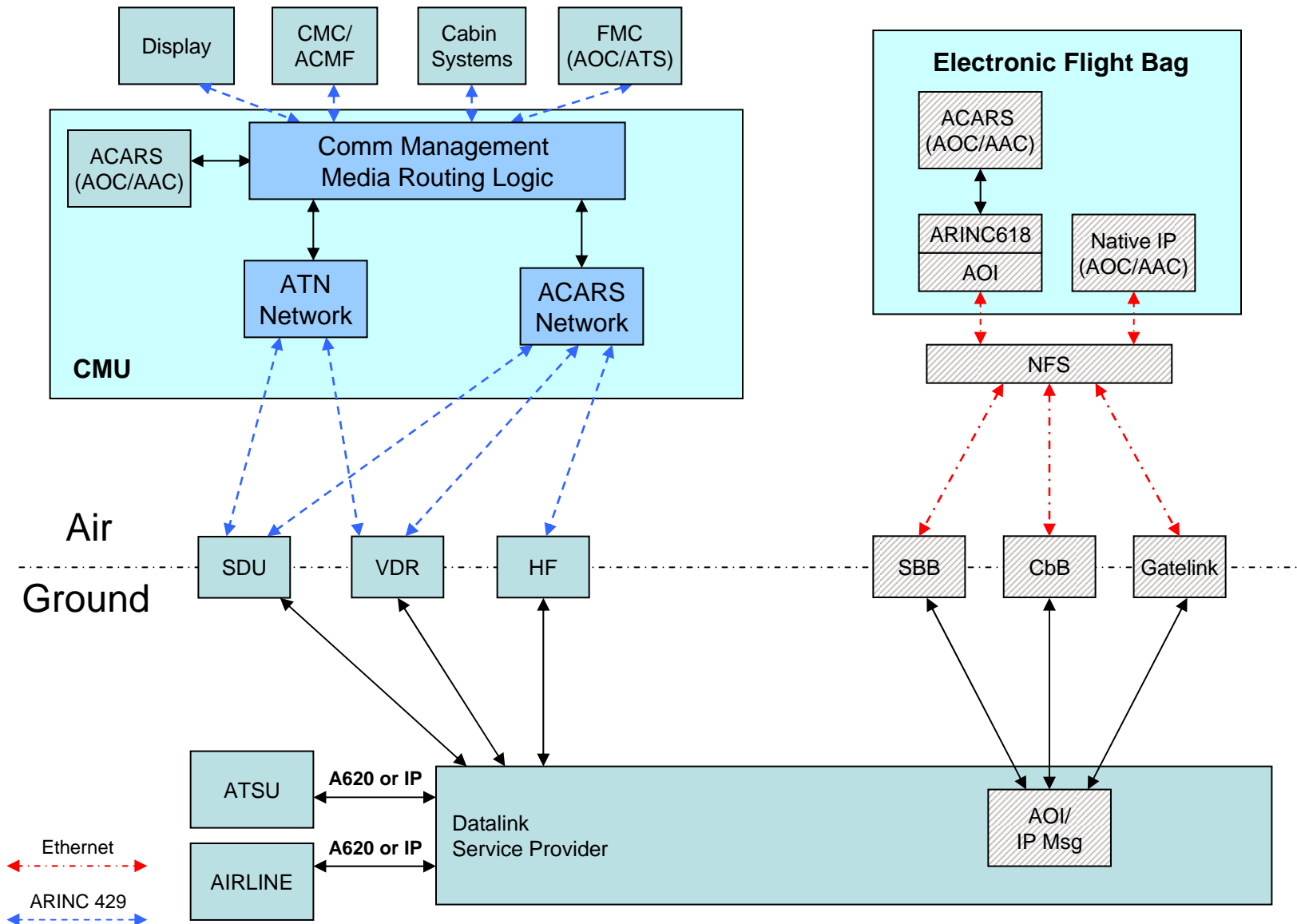
# Back-Up Slides



# Alternate Architecture Configuration (No CMU Updates, ACARS and AOI Functionality in EFB)

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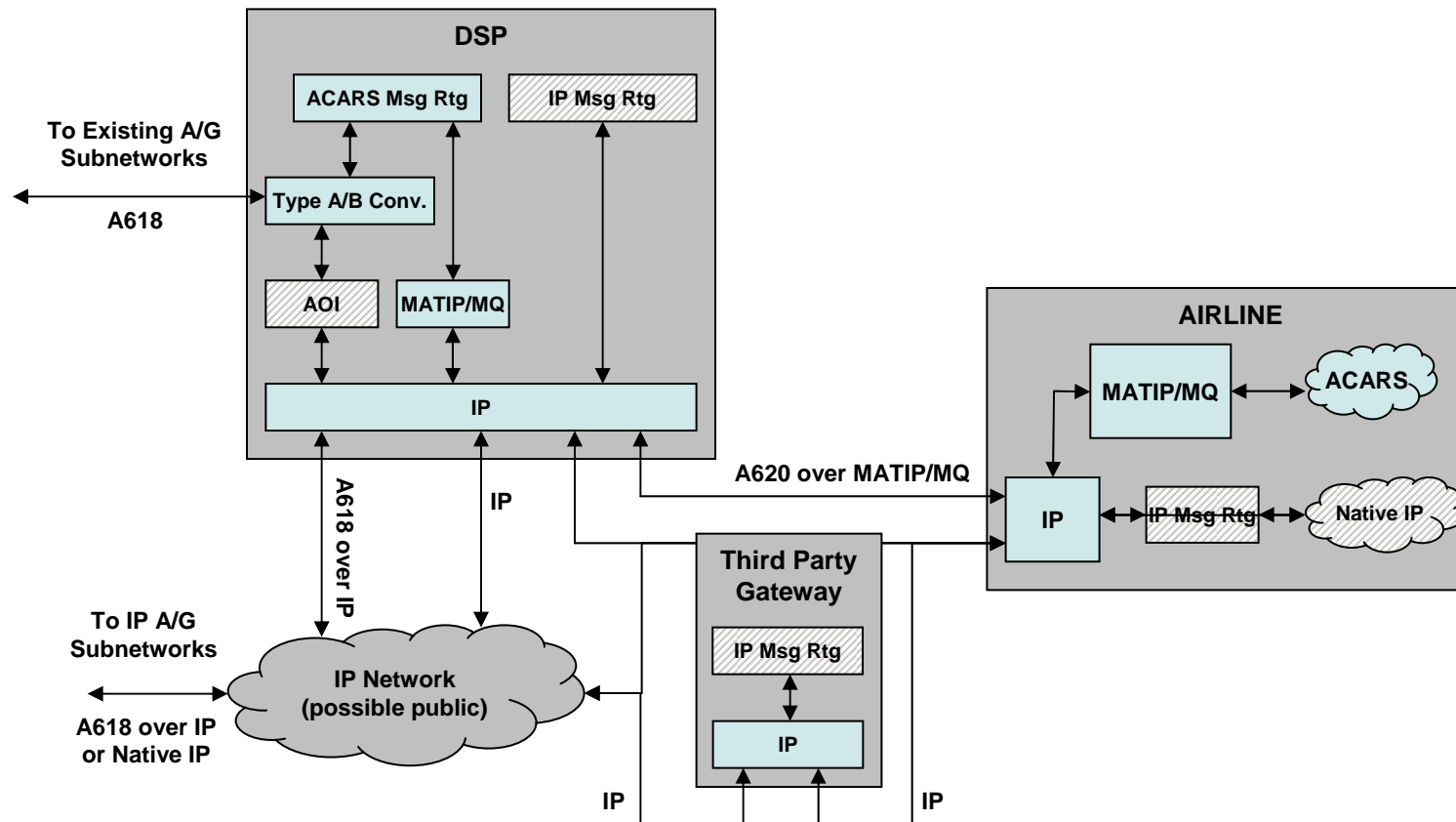
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# Alternate Architecture Configuration (IP Messaging Location)

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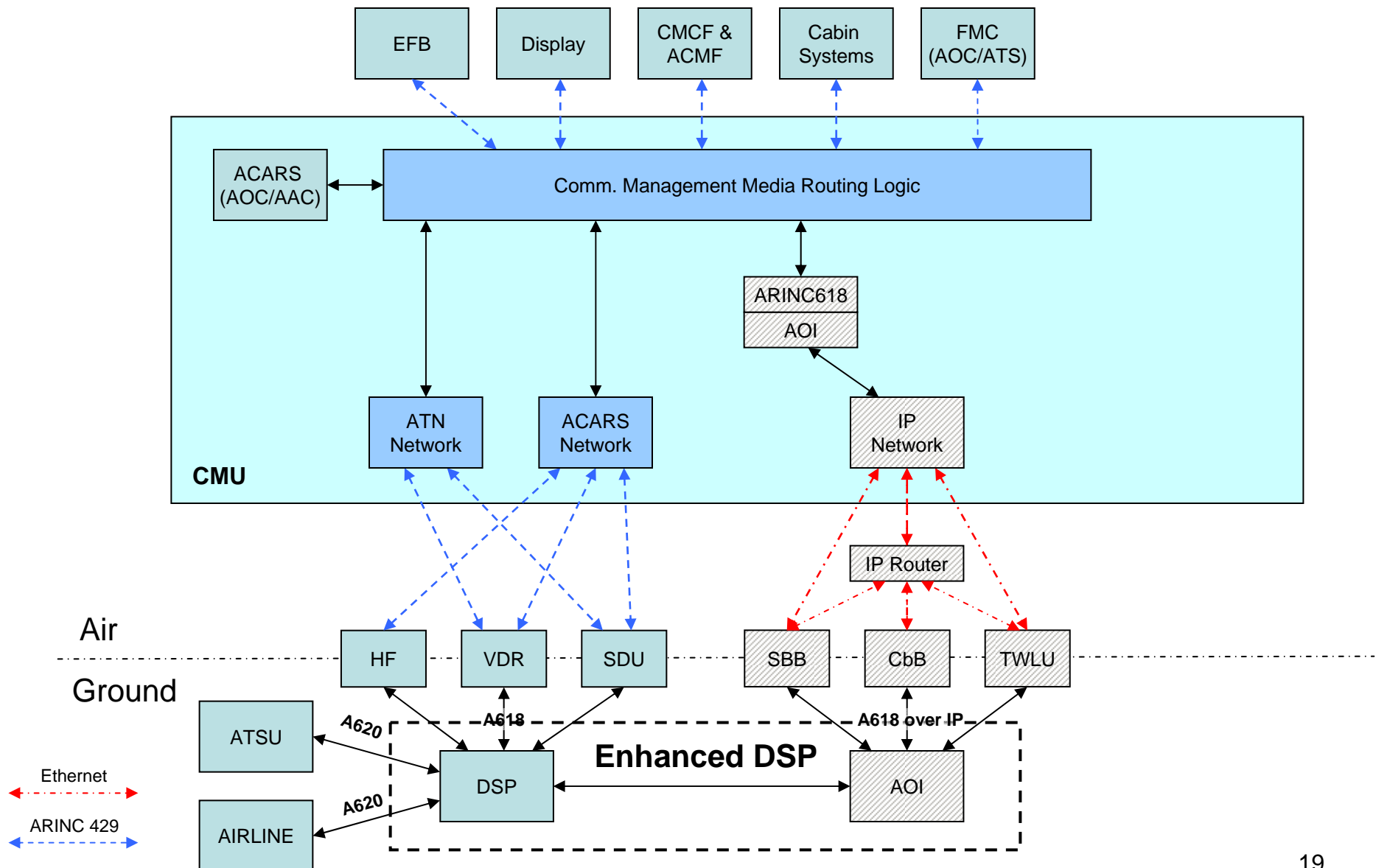
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# Architecture Alternative Configuration (IP routing location)

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# Definition of Terms

- **Air Traffic Services (ATS):** Datalink between aircraft and Air Traffic Service Provider (ATSP).
- **Airline Operations Communications (AOC):** Datalink between aircraft and airline operations center. Could include Safety of Life Communications.
- **Airline Administration Communications (AAC):** Datalink between aircraft and airline operations center. Non Safety of Life.
- **Air Traffic Service Unit (ATSU):** Logical entity that integrates all services dedicated to data communication between aircraft and the air traffic centers
- **Aircraft Communications Addressing and Reporting System (ACARS):** Legacy character based datalink protocol between aircraft and ground (Airline, ATSU).
- **Datalink Service Provider (DSP):** controller of the ground network and messaging service (e.g. ARINC, SITA) .
- **Aeronautical Radio, INCorporated (ARINC):** An international body of airline representatives that provides DSP services and leads the development of technical standards ACARS specifications.
- **Broadband IP subnetworks:** Wireless IP links between modems in the aircraft and ground stations (e.g. SwiftBroadband (SbB), Connexion by Boeing (CbB), Gatelink). (i.e. in the 432 kbps – 10 to 40 Mbps)
- **Native IP:** AOC and ATS applications developed specifically to run over IP (IPv4 and/or IPv6)